CEFood & Congress

Novi Sad, Serbia
23 - 26 May, 2012

PROCEEDINGS

of 6th Central European Congress on Food

IUFoST International Union of Food Science and Technology

EFFoST European Federation of Food Science and Technology

CEI Central European Initiative

EFFECT OF DRYING ON THE PHYSICAL PROPERTIES OF QUINCE

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ABSTRACT: This study aimed at evaluating the textural properties of quince in fresh and after drying at different conditions. In parallel, colour was also measured to evaluate how the visual aspect of the product changed with drying. The experiments were done in a tunnel drier, at different temperatures, from 30 to 60ºC, and different air velocities, varying in the range 0.7 to 1.2 m/s. The colour coordinates of the fresh quince were: L* = 78.02±0.86, a* = - 1.27±0.32 and b* = 31.75±1.68. These values indicate that the samples were bright, because L* was closer to 100 than to 0. Furthermore, it can be seen that quince was greenish, although very slightly and strongly yellowish. With drying, the samples became darker and redness was intensified, as a result of browning. In relation to the textural properties in fresh, the values were: hardness = 48.46±6.47 (N), springiness = 74.86±5.17 (%), cohesiveness = 0.75±0.06, resilience = 0.47±0.08 and chewiness = 27.23±4.06 (N). Furthermore, it was observed that drying, regardless of the conditions, induced an important hardening, increasing hardness and diminishing springiness.

Key words: *quince, drying, texture, colour, hardness*

INTRODUCTION

Quince is characterized by many flavour compounds derived from oxidative degradation of carotenoids, with the majority of them belonging to the class of thirteen carbon (C_{13}) norisoprenoids (Lutz-Roder et al., 2002). In addition to their potent antioxidant activity, it has an anti-inflammatory effect of a non-toxic, cost-effective natural agent (Essafi-Benkhadir et al., 2012). The chemical composition of its fruits (*Cydonia oblonga* Miller) range from 11.5 to 14.7 ºBrix, with fructose and glucose as predominant sugars, malic acid (0.78 %) as the main organic acid, followed by tartaric (0.22 %) and citric acids (0.009–0.014 %), besides having a low fat content. Furthermore, quince also is a source of dietary fibre, mostly pectic and cellulosic polysaccharides, and consequently it has been used in production of fibre rich powders (Pla et al., 2010; Thomas et al., 2000, Rodríguez-Guisado, 2009).
Besides its nutritional properties and health benefits, quince is used mostly for cooking preparations such as cookies, jellies, jams or marmalades since it is relatively hard, bitter and astringent (Silva et al., 2006). However, as the drying allows softening the pulp of the fruits, dried quince appears as an alternative to its fresh consumption. Different methods of drying are used to dry fruits and vegetables but all of them have a potential impact on the quality of the dehydrated products, namely on colour and texture properties. Therefore, the evaluation of both characteristics after drying is a pivotal aspect, since there is a strong impact on acceptability by consumers. Many works in the literature have studied the impact of different drying methods on the quality and properties of different fruits and vegetables such as red pepper (Doymaz and Pala, 2002), blueberries (Shi et al., 2008), potato (Leeratanarak et al., 2006), banana (Prachayawarakorn et al., 2008), apple (Mandala et al., 2005), bell pepper and pumpkin (Guiné and Barroca, 2011, 2012), mushrooms and onions (Guiné and Barroca, 2011a). Even though there have been a few works on drying of quince (Kaya et al., 2007; Koç et al., 2008) none of them has analysed their quality attributes.
The present study aims to compare the colour and texture properties of the quince in fresh and after drying in a tunnel drier, at different temperatures, from 30 to 60 ºC, and different air velocities, varying in the range 0.7 to 1.2 m/s.

MATERIAL AND METHODS

Drying

Quince was washed and cut into slices which were placed in a tunnel drier (Tray Drier UOP-8, Armfield). Drying experiments were performed under different conditions, namely varying air velocity and temperature. The values tested for air velocity were 0.7, 0.9 and 1.2 m/s and the temperatures essayed were 40, 50 and 60 ºC.

Colour evaluation

The colour of the fresh and dried samples was measured using a handheld tristimulus colorimeter (Chroma Meter - CR-400, Konica Minolta). A CIE standard illuminant D65 was used for calibration and the colour coordinates L*a*b* of the CIELab colour space were determined. From the Cartesian coordinates (L*a*b*) the total colour difference (ΔE) was calculated by equation (1):

$$\Delta E = \sqrt{(L*_0 - L*)^2 + (a*_0 - a*)^2 + (b*_0 - b*)^2} \qquad (1)$$

having the fresh product as reference, with coordinates $L*_0$, $a*_0$, $b*_0$.

The Cartesian colour coordinates were then used to calculate the cylindrical coordinates, chroma and hue, by the following equations:

$$Chroma = \sqrt{a*^2 + b*^2} \qquad (2)$$

$$Hue\ (^o) = atan\left(\frac{b*}{a*}\right) \qquad (3)$$

For the colour determinations twenty samples were analysed for each state (fresh and different dryings) and the mean values and standard deviations were calculated for each set.

Texture measurements

Texture profile analysis (TPA) to all the samples was performed using a Texture Analyser (model TA.XT.Plus from Stable Micro Systems). The texture profile analysis was carried out by two compression cycles between parallel plates performed using a flat 75 mm diameter plunger, with a 5 second period of time between cycles. A force load cell of 5 kg was used and the test speed was 0.5 mm/s. TPAs were performed in 20 samples for each state, and the textural properties: hardness, springiness, resilience, cohesiveness, and chewiness were calculated after the following equations (see Figure 1):

$$Hardness\ (N) = F_1 \qquad (4)$$

$$Springiness\ (\%) = \Delta T_2/\Delta T_1*100 \qquad (5)$$

$$Resilience = A_2/A_1 \qquad (6)$$

$$Cohesiveness = A_3/(A_1+A_2) \qquad (7)$$

$$Chewiness\ (N) = F_1 * \Delta T_2/\Delta T_1 * A_3/(A_1+A_2) \qquad (8)$$

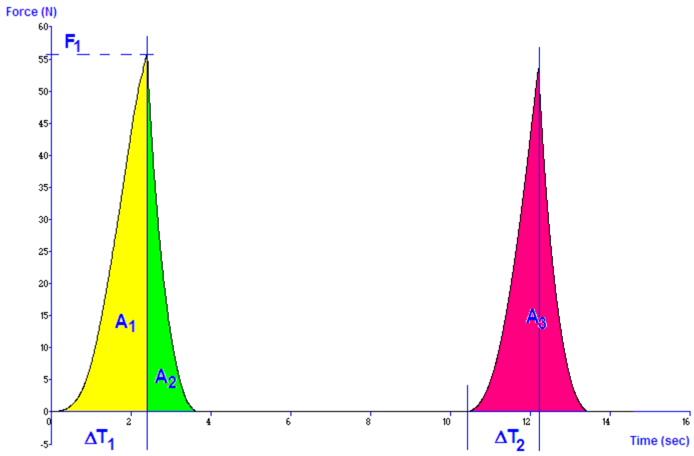

Figure 1. Example of a texture profile analysis.

RESULTS AND DISCUSSION

Figure 2 shows the variations through time of the experimental values measured for the Cartesian colour coordinates: L*, a* and b* for fresh and dried quince. The values of these coordinates indicate that the quince fresh pulp is clear (L* = 78.02±0.86), slightly green (a* = - 1.27±0.32), and very yellow (b* = 31.75±1.68). In general, drying produces a darker, redder and more yellow product when compared to the fresh product. Furthermore, it is possible to see that the increase in temperature from 40 ºC to 60 ºC had a small effect on the colour parameters since the brightness, L*, and the two opposing colour, a* and b*, ranged, respectively, from 74.41 to 71.80, 8.09 to 9.33 and 35.77 to 37.23.
For a temperature of 60 ºC, the increase in air velocity from 0.7 to 1.2 m/s also had a reduced effect on the colour parameters.

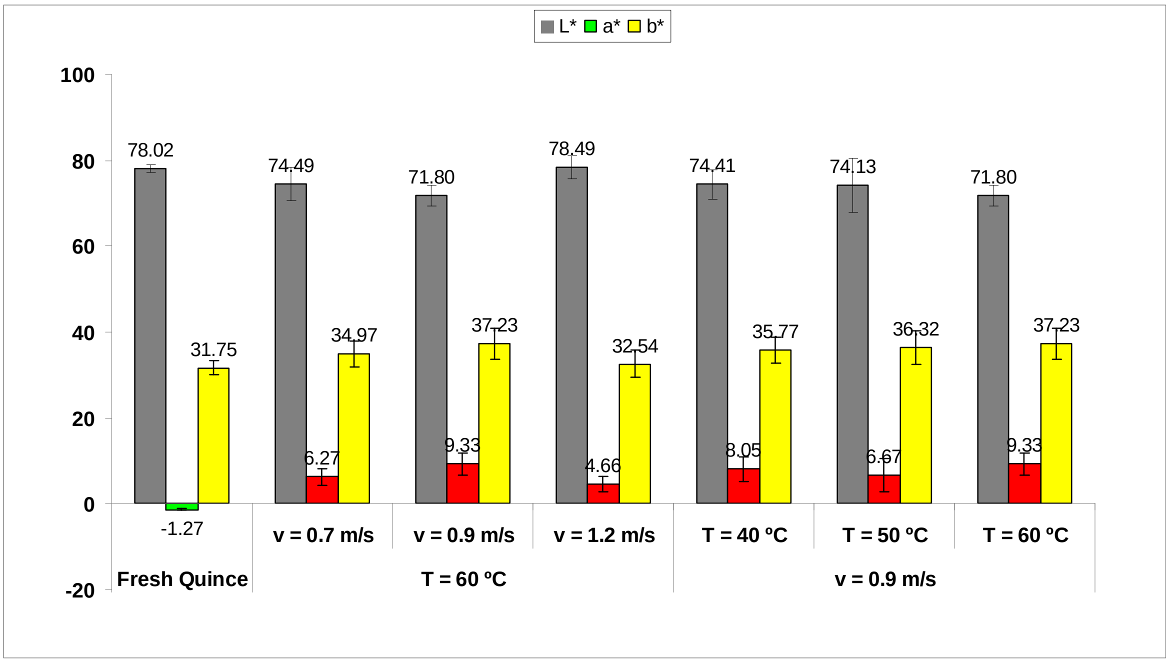

Figure 2. CIELab colour coordinates for fresh and dried quince.

Figure 3 reveals the total colour difference, which was calculated according to Equation (1), and quantifies the deviation of colour in relation to the reference colour. The range of temperatures and velocities studied induced a maximum colour difference of 13.45 in relation to the fresh quince, and this happened for the drying at 60 ºC and 0.9 m/s.

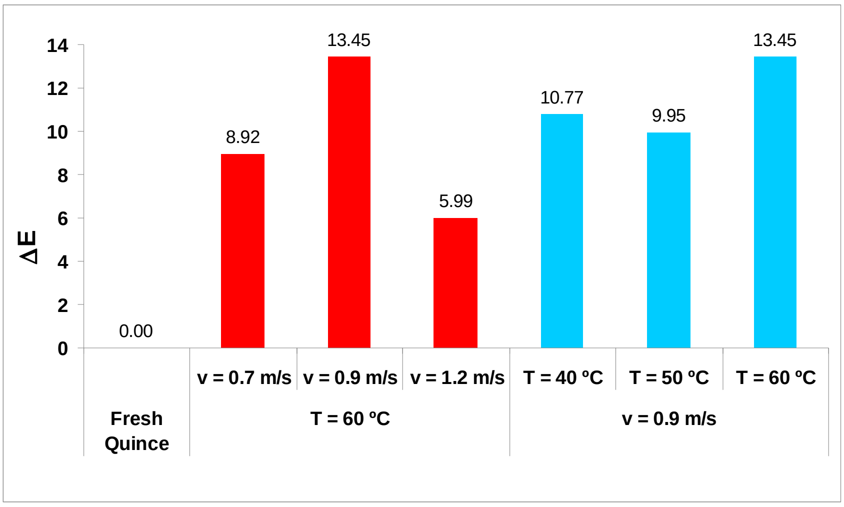

Figure 3. Total colour difference for dried quince samples.

Figure 4 presents the cylindrical coordinates, chroma and hue angle, calculated by Equations (2) and (3).The tunnel drying induces a small effect on intensification of colour (chroma), but moves the hue angle from the yellow colour to the red zone, although staying far from the fully red (0º), as compared with the fresh state. However, the operating factors temperature and air velocity had a slight effect on both cylindrical coordinates.

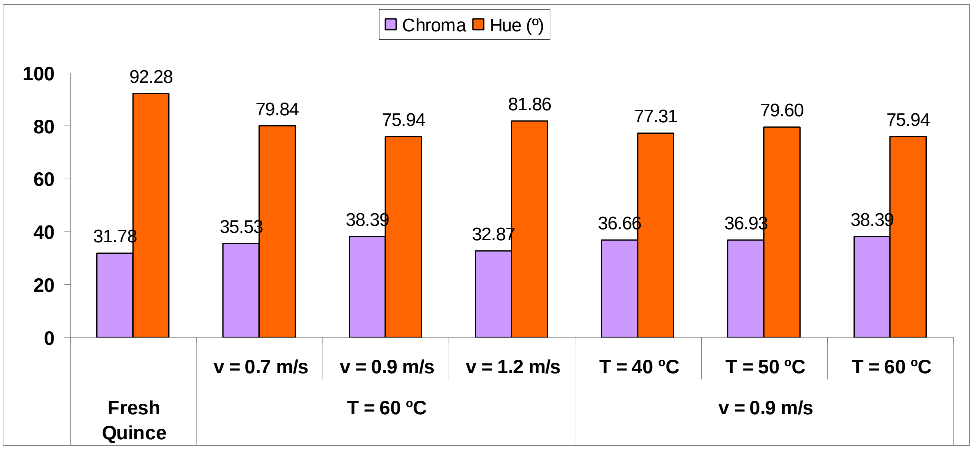

Figure 4. Cylindrical colour coordinates for fresh and dried quince.

Figure 5 highlights the results of hardness and chewiness obtained for the fresh and dried quince. It can be seen that the hardness of fresh quince is much lower than that of the dried state, independently of the operation conditions. This means that the drying intensifies the quince hardness and, consequently, the dried quince requires more energy than the fresh quince for the first bite. The hardness of fresh quince is 48.46 N against 87.26 N and 103.62 N, respectively, for 40 ºC with 0.9 m/s and 60 ºC with 1.2 m/s, which are the minimum and maximum values obtained after drying. However, the effect of drying on the energy required for chewing the quince until it is ready for swallowing, measured by the chewiness, is much less pronounced than in hardness.

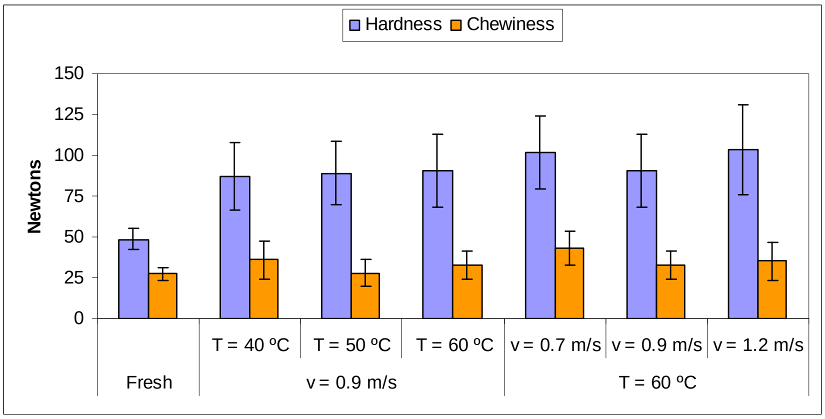

Figure 5. Hardness and chewiness of fresh and dried quince.

As seen in Figure 6, the drying has no visible effect on cohesiveness, which is related to the strength of the internal bonds of the sample neither on the capability of the sample to recover its size and shape after deformation (resilience).

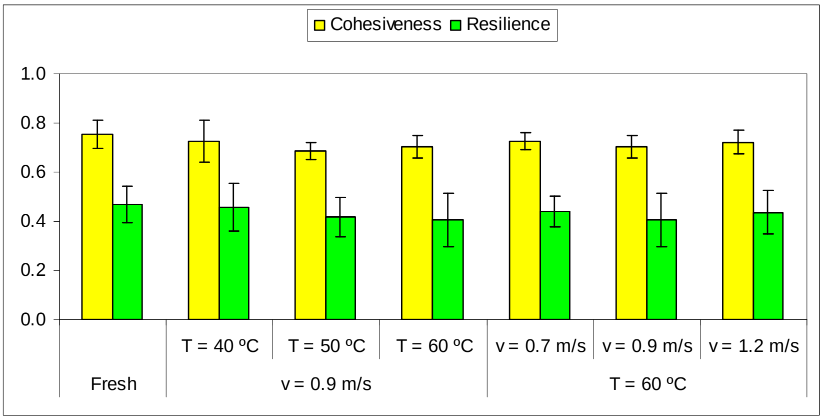

Figure 6. Cohesiveness and resilience of fresh and dried quince.

Figure 7 reveals that drying contributes to the reduction of the springiness of quince since the value of 74.86 % in fresh fruit is decreased to values near 50 % after drying.

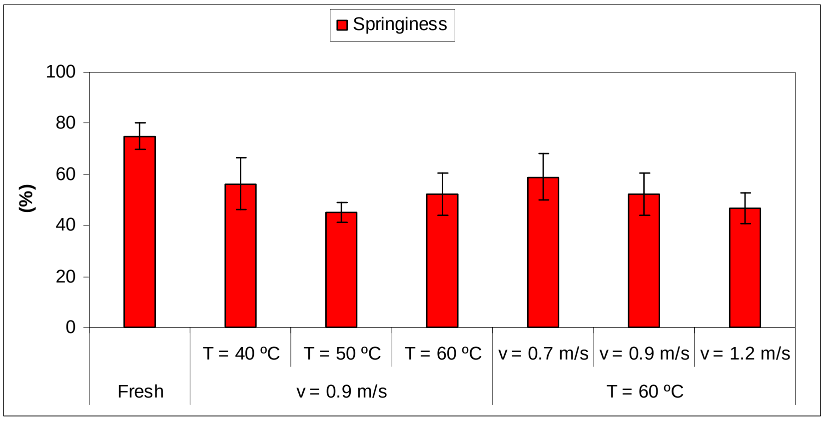

Figure 7. Springiness of fresh and dried quince.

CONCLUSIONS

Based on the results it was possible to conclude that tunnel drying produces a darker, redder and more yellow product, in relation to the fresh product, independently of the experimental conditions used. Besides that, the increase in temperature and air velocity had a slight effect on colour attributes (maximum colour difference, chroma and hue angle) in the range of temperatures and air velocities studied.

With respect to the textural attributes, it was observed that tunnel drying substantially influenced the hardness and springiness, regardless of the conditions, since induced an important increasing in hardness and a decreasing on springiness. The chewiness is another textural property that increases with drying, although not so strongly as hardness. The values of cohesiveness and resilience were not affected with drying, since the value in the fresh state is approximately the same as in the dried state, independently of the temperature and air velocity.

ACKNOWLEDGEMENTS

The authors thank the financial support to the research centres CI&DETS (Viseu) and CERNAS (Coimbra).

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